DEPRECIATION RULES

Investment in each budget cycle adds new capital, but at the same time the existing capital stock is being worn out by use, age, and obsolescence. Unless the annual additions exceed depreciation on existing assets, no net additions to the capital stock result. Tracking the effects of federal investment therefore requires not only evaluating additions to assets but also developing measures of capital consumption (depreciation).

All depreciation deductions are to some extent arbitrary. In business accounts, they are based on the principle that using assets reduces their remaining store of services and that the costs of those reductions should be reflected in production costs. But except for the partial information from secondhand asset sales, the extent of that exhaustion is not observable. New, nearly new, and old buildings and machinery often perform at about the same apparent efficiency. Furthermore, the value of a nearly new machine may be suddenly eroded by a technical change in process or a change in buyers' tastes that reduces demand for its product. In charging off depreciation, therefore, firms use accounting rules that reflect practices in their industry, tax rules, and a host of other factors including expectations about used asset prices, demand, and technological obsolescence.

No such practices, rules, or expectations establish obvious precedents for measuring the depreciation of public capital. Moreover, there are no clear parallels between federal and private business activity on which to base depreciation rules. For example, government accountants cannot often rely on used asset prices from secondhand markets to help set depreciation policies. In principle, one could estimate appropriate depreciation allowances from the contributions public capital makes to production, but this is complicated by its public use. The income against which public depreciation should be charged is not federal "income" but the income firms derive from using the capital stock. Depreciation of a dam, for example, is not properly deductible from federal tax revenue but from the income of farmers who use dam water to grow crops, because it is part of their inputs and should be covered by the prices they receive for their production. But often dams also provide water to towns; water flowing through dams turns turbines that generate electricity; and dam structures protect downstream property from the threat of floods. No obvious choice among the depreciation practices used in farming, water and power supply, real estate, or flood insurance presents itself.

No practice exists for depreciating human or intangible capital. It is difficult to establish parallels with physical capital formation and the deterioration of physical stocks that would justify simply using business depreciation methods. Whereas machinery or a building is put into service on a specific date, the development of human and intangible capital in such fields as teaching, medical care, and research is an ongoing process. Furthermore, the asset created (skill, knowledge) persists undamaged and may be enhanced by use; only its earning power eventually wanes. Thus there is neither a clear starting point for depreciation nor an obvious rate at which these assets should be written off. Moreover, no depreciation rate could be uniform for all activities or occupations, and using broad averages would oversimplify the effects of shifts in the work force structure.

The approaches to measuring net changes in physical and other capital used in this study are described below.

Physical Capital

Failing a clear choice, this study has adopted two ways of measuring net investment in physical capital that broadly correspond to business practices in accounting for depreciation:

- Making equal deductions from investment over assets' service lives (the so-called straight-line method); and

- Deducting asset values from investment only at the end of their service lives.

The first gives a measure similar to NIPA measures for other sectors; the second results in a measure sometimes called gross investment net of retirements. Each has its advantages. The first, deducting depreciation in equal installments, has the advantage of simplicity, but it is not necessarily appropriate in all cases. A 100-year dam, for example, is not twice as productive in its first year as in its fiftieth. Many large physical assets provide "as new" service for most of their lives, and, with proper maintenance, remain in good service condition until replaced.

The alternative net investment measure therefore assumes that assets remain in near-new condition until close to the end of their lives, and then deteriorate rapidly. Since the choice of this decay point is arbitrary unless continual surveys are made of the assets' condition, the second measure used ignores changes in services from assets until they are withdrawn from use altogether. It thus combines the advantage of simplicity with that of better reflecting service efficiency. For this analysis, assumptions as to service lives, asset replacement rates, and decay of capital input are those used by the Bureau of Economic Analysis (BEA) in compiling its data series on the nation's reproducible wealth.7/ Details are shown in Appendix A. The effects of varying these assumptions are also shown for key investment series.8/

Human and Intangible Capital

Measuring net additions to human and intangible capital raises somewhat different issues. As noted earlier, there are no estabished practices in business accounting that could be used as models. Some help may be found in the fields of growth accounting and technical change. The guiding principle is the same as for physical capital--changes in net stock should reflect changes in the amount of capital services available for producing national income. Four types of adjustment between gross investment and net wealth increases are needed.

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7. For definitions and methods, see Department of Commerce, Bureau of Economic Analysis, *Fixed Reproducible Tangible Wealth in the United States, 1925-1985* (June 1987). Data series are published and updated from time to time in the Commerce Department's *Survey of Current Business*.

8. The BEA also provides data on net stock based on a rapid decline in asset values over the last few years of service, rather than a sudden withdrawal at the end of service life. Net investment in this series lies between, and shows similar trends to, the two series presented in this report. Independent estimates of state and local investment that assume depreciation will mirror prices of used private assets, and that generally shorten service life assumptions, produce a net investment series for public capital that is also within the range, and with the same trends, as these estimates. See Michael J. Boskin, Marc S. Robinson, and Alan M. Huber, "New Estimates of State and Local Government Tangible Capital and Net Investment," Working Paper No. 2131 (New York: National Bureau of Economic Research, January 1987).

Consumption versus Investment. First, separating purchases of goods for consumption from purchases of investment goods can usually be done fairly clearly. In education, health care, and research spending, however, consumption and investment elements may be mixed in the same transaction. A net investment series has to exclude the consumption shares. Kendrick, for example, excludes half of health care spending from human capital formation, treating it as consumption, although his choice of the proportion is arbitrary.9/ Kendrick also includes all education spending as investment, but recognizes that much education is direct consumption and that education enhances many leisure activities.

For health care, developing a series for investment in human capital seems particularly susceptible to arbitrary assumptions. Choices of medical treatment seem less likely to be made with a view to their income effects than to improvements in general health and personal well-being. Education, on the other hand, is commonly undertaken with job prospects or career moves in mind; and research programs, even when they involve much experimentation, are eventually expected to generate fruitful innovations. For lack of a way to disentangle consumption and investment elements, this paper offers only broad indicators of investment in human capital.

In the field of research and development, the need for consumption adjustments to separate investment from other spending seems likely to be small. Rather, data on intellectual investment must necessarily ignore the vast but uncountable contribution of on-the-job experience (learning-by-doing) to industrial and commercial innovation. Formal research and development activity is thus a convenient, but not a comprehensive, measure of investment in scientific capital. A different type of deduction may be necessary to exclude from the capital formation series R&D spending aimed at noncommercial innovations. In particular, many analysts argue that military performance specifications for new equipment and systems are now so greatly different from those that would support successful commercial adaptations that the development portions of military R&D programs no longer contribute to commercial innovations. This implies that military devel-

9. See John W. Kendrick, *The Formation and Stocks of Total Capital* (New York: National Bureau of Economic Research, 1976).

opment expenditures should no longer be thought of as sources for commercial spinoff innovations (and thus part of the nation's expanded capital base), but should be classed with other noncapital programs within military spending. Furthermore, it has been argued that, because of their different objectives, military programs are an increasingly inefficient way to seek commercial innovations.10/ Thus, even allowing commercial spinoffs from military development programs, the commercial value of the knowledge may be less than that from the same spending in other R&D programs.

Time Lags. Time lags between investment and changes in the productive capital base are longer for human and intangible capital than for plant and equipment. Kendrick uses the age of 28 years as the "maturation age" for education investment, and the age of 18 years for health investment.11/ At 28 years, his data show, the earning potential of a person's education is maximized. Under his method, all spending is accumulated (like "work-in-progress" for construction projects) until age 28 (or 18) when returns on the investment begin to be realized. Because of the longer gestation period, an investment in education may appear to have relatively smaller effects on work-force skills than a physical investment offering the same return. But, since only broad indicators of investment in human capital are shown, no adjustments for these time lags are made in this study.

Measured Output. Since the aim is to clarify changes in national income, components of human or intangible capital that do not contribute to output changes as measured should be deducted from investment. In principle, research applied in nonbusiness activity, and investment that aims at introducing new products, should be excluded in favor of investment that increases quantity or lowers costs of production. New products carry quality changes that are not easily measured in national output data, so that including their related

10. Nathan Rosenberg, "Civilian Spillovers from Military R&D Spending: The American Experience Since World War II" (paper prepared for presentation at the Conference on Technical Cooperation and International Competitiveness, April 2-4, 1986, Lucca, Italy). This may also be true for basic and applied research that may be subjected to secrecy restrictions if conducted by military scientists but not if conducted by private scientists.

11. Kendrick, *The Formation and Stocks of Total Capital*.

research overstates the size of the capital base needed to generate recorded income levels.

Views differ as to how much of federally funded research is directly associated with measured income growth. One analyst has estimated that only half of R&D spending affects productivity as measured, and that only half of that amount adds to the net stock of productive knowledge. He excludes R&D spending for defense, space exploration, health, and environment, and also for industrial applications (such as computers) that aim at quality change.12/ On the other hand, industry analysts underscore the difficulties of identifying what will be discovered in any experimental project, or how any discovery will make its way to the production line. All basic research contributes generally to knowledge, with no boundaries on the potential applications of its findings. Applied research, though oriented to a particular outcome, ranges fairly widely for solutions. 13/ Only in the development stage do researchers seek particular and dedicated solutions that may or may not be adaptable by other users. For these reasons, this study presents net additions to R&D capital in two series. The first excludes development expenditures for defense, space, health, and environment, and the second makes no deductions.

Depreciation. The net additions to capital should also reflect capital used up in production. In knowledge-oriented investment--that is, basic and applied research--depreciation, in the sense of a gradual withering away of the assets, is generally not taken account of. Knowledge, once found, remains intact, is not eroded by production processes, and therefore need not be replaced. Once the accountant has adjusted investment streams for consumption, time lags, and quality factors, net stocks are affected further only by retiring R&D assets. In these estimates of intangible investment, development expenses are written off evenly over a 10-year period beginning five years after the expenditure was incurred.

12. Zvi Griliches, "R&D and the Productivity Slowdown," *American Economic Review*, vol. 70 (May 1980).

13. Some analysts class applied research with development, as product-oriented activity, rather than with knowledge-seeking basic research.

Human capital is exhausted with age, or when workers retire, but such retirements (in a human capital accounting framework) reduce capital values that are wholly within the household sector. Moreover, the share of such retirements traceable to past federal education and health programs is unknown, although estimates of retirements have been compiled on a national scale. No deductions can be made from federal health, education, or training subsidies to adjust for (uncounted) retirements of workers benefiting from federal programs. Reductions in the training capital of federal employees, however, are taken account of as trained employees leave their jobs.

Net Additions from Subsidies and Grants

On detailed points, converting gross measures of the investment effects of grants and other subsidies to net measures would follow the procedures outlined above for physical, human, or intangible capital according to the type of investment financed. Thus a grant for highway construction would be treated as generating an addition to net capital in accordance with the measurement rules for physical capital, and a guaranteed student loan would be treated according to the rules for human capital formation.

A more important question is where these additions are to be credited. On a national level, attributing subsidized investment to any sector does not alter overall totals as long as double counting is avoided. Including the gross contributions to subsidized investment with federal investment acknowledges the financing source for the subsidies. On a sectoral level, however, contributions to net national saving and investment conventionally reflect who has the care and custody of the assets. This study therefore credits net investment effects under subsidies to the investing sector--state and local governments or private businesses and households--rather than to federal budgets. It shows net federal and national contributions to capital formation after crediting subsidized investment to the sectors that benefit from it.

CHAPTER IV

DIRECT FEDERAL INVESTMENT

This chapter estimates direct federal investment activity on the basis of the concepts used in the national income and product accounts (NIPA) to define investment by businesses and households. Under these principles, federal physical investment is seen as heavily concentrated in large construction projects--dams and other water resources improvements, and heavy engineering plant. Apart from occasional spurts of residential investment, direct federal investment in other types of capital is small.

The estimates of net physical federal investment in this report are based on Bureau of Economic Analysis data that are part of the official series on national capital stock. Thus, federal capital spending is, in some official data, already counted as additions to the nation's "capital," although changes in that government capital stock are not counted as part of national investment. Since the federal investment is small, however, including it in national investment would not markedly shift estimates of national saving as a percent of net national product (NNP).

The principal difficulty arises in estimating the depreciation on past investments. The range of depreciation measures that would reflect federal capital consumption under reasonable estimates would lead to measures of net investment that vary by as much as one-third in some categories. Rate of return estimates also suggest that construction costs may overstate the investment values of current federal projects.

MEASURING PHYSICAL INVESTMENT--THE NIPA STORY

Federal investment under the strict application of national income accounting principles would include only physical assets financed and owned by federal agencies. Taken as a whole, such net federal

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contributions to physical capital have been $4 billion a year or less (at 1982 prices) since the mid-1970s, depending on the choice of depreciation method. Since 1978, federal purchases of physical assets have hovered around $13 billion a year, and estimated allowances for assets taken out of service have been around $9 billion annually. Thus if depreciation is charged only when assets are withdrawn (the lower of the two measures used), net federal investment could be estimated at around $4 billion a year (see Table 3). If depreciation is instead measured on a "straight-line" basis (by deducting equal annual installments of the value of the assets over their useful lives) net investment over the same period appears to have fluctuated around zero (Table 4). Thus the use of NIPA concepts to measure federal investment would not markedly change current estimates of federal saving and of the federal budget's impact on net national saving and investment.

When using the national income accounting format employing the strict "physical plant and equipment" definition, the largest components of federal investment are dams and other structures constructed under federal water resources and energy programs; military buildings and other fixed military facilities; and industrial plant, particularly the large industrial equipment used principally in the construction of military ships and aircraft. Trends differ among these components:

- Except in times of sudden bursts of military spending--as during the Second World War and in the strategic expansion lasting from the early 1950s to the early 1960s--federal spending on military facilities (other than strategic vehicles and weapons) has been less than either of the measures of depreciation used in this study. The small positive net investment now evident in Table 3 follows a 46 percent spending boost between 1982 and 1986, and is the first net addition to capital under either measure since 1976. Thus the measured contribution of military programs to net capital formation has usually been negative.

- Net investment in water and energy structures follows cycles of about 15 years, with falling net spending between 1978 and 1985 representing the downward phase of the last cycle, pending the program's reauthorization in 1986.

- o Net federal investment in heavy industrial equipment, reflecting federal purchases of the military ships, aircraft, and weapons it is used to construct, increased rapidly in 1982 and 1983. Equipment purchases by federal enterprises have been on the upswing since 1982. However, because of large write-offs under both methods, net investment remains negligible, and similar to the typically negative levels throughout much of the 1970s.

Military Investment

The persistently negative net investment in military structures except in emergency periods does not necessarily reflect any inadequacy in military facilities. Rather, it follows from the pattern of military affairs. During national crises, military facilities are rapidly expanded, both by commandeering private facilities and through crash construction and expansion programs that lead to sharp peaks in military investment. These peaks account for the higher overall federal net investment rates shown in Figure 2 for 1949 through 1966. During World War I, real annual investment spending on military bases was 40 times more than the average of the previous five years; during World War II, spending rose to a level 18 times above prewar averages; and in the arms buildup of the 1950s, yearly investment spending was 24 times that of the late 1940s. These peaks build capacity in bases far beyond peacetime needs, and at the same time provide facilities that may become outdated as technologies change. In many cases, book values for these assets may greatly overstate their real usefulness for current military purposes--in some cases because they exceed peacetime requirements, and in others because they are militarily obsolete. A military accounting of these assets, therefore, would probably allow faster write-offs of wartime assets. Moreover, military managers may replace the services of older assets by renting or leasing from private investors rather than investing directly, so that the condition of owned facilities may in some cases not be typical of the facilities in use.

From a civilian point of view, however, the persistent negative net investment in these assets means that they are increasingly irrelevant to the national productive capital base. Nominally, all are tradeable assets--hangars, offices, and so on--that, at least in principle, could be leased, and excess capacity sold. The fact that they have not been sold to other users (as was done with wartime factories, for example) indicates that in practice their transferability to civilian uses is limited. This may be because of the costs of converting them to commercial and private use, or, probably more commonly, their location in places where use by private owners would impede military operations. While from a national accounting point of view, investment in military buildings and facilities is a federal counterpart of

TABLE 3. NET FEDERAL PHYSICAL INVESTMENT AFTER DEDUCTING ASSETS WITHDRAWN FROM SERVICE (NIPA basis, in millions of dollars, at 1982 prices)

	Structures					
	Civilian Nonresidential					
	Buildings			Other Civilian Nonresidential		
Year	Industrial	Hospital and Education	Other	Highways	Conservation and Development	Other
1949	574	633	359	251	3,315	126
1959	379	171	519	355	3,219	135
1969	-379	242	-37	586	2,830	46
1970	-663	327	-73	635	3,066	78
1971	-519	374	-43	670	3,405	125
1972	-893	242	-122	661	3,417	348
1973	-820	275	-22	536	3,572	452
1974	-945	257	-140	375	3,646	329
1975	-1,099	288	180	412	3,560	303
1976	-1,147	306	-81	468	3,602	327
1977	-1,186	365	966	540	3,597	327
1978	-1,564	416	414	479	4,346	324
1979	-1,526	382	487	490	4,004	222
1980	-1,463	424	455	337	3,868	176
1981	-1,676	468	497	620	3,564	119
1982	-1,550	365	156	559	2,966	132
1983	-1,489	334	365	376	2,719	89
1984	-1,364	366	578	397	2,465	132
1985	-1,265	382	730	295	2,284	-97
1986	-914	404	800	227	2,091	289

SOURCE: Congressional Budget Office, based on data from the Bureau of Economic Analysis.

household home ownership since it avoids rental payments, it does not bulk large enough to be significant.

Water and Energy Resources

Fluctuations in net investment in the conservation and development of water and energy resources reflect funding patterns. Spending,

TABLE 3. (Continued)

Structures (Continued)		Equipment		
Residential Investment	Military Structures	Industrial	Other	Net Federal Investment Type 2 a/
-576	-54	1,258	-785	5,102
1,874	4,147	1,451	190	12,440
315	104	1,111	947	5,765
400	-261	784	377	4,671
1,046	673	1,078	-270	6,541
1,974	260	-263	1,268	6,894
1,777	-158	141	-46	5,706
1,492	-931	-226	-30	3,827
356	272	-384	-431	3,459
177	473	-288	-581	3,256
468	-562	314	-845	3,984
799	-797	55	-784	3,688
328	-1,732	-1,478	-520	657
664	-430	129	-23	4,137
595	-326	336	-329	3,868
480	-1,379	807	-1,446	1,090
948	-673	1,943	-1,320	3,292
1,254	-1,392	-59	-790	1,588
1,329	206	-202	-608	2,189
1,886	872	-95	-829	4,730

a. Net Federal Investment Type 2 is gross investment less the value of assets withdrawn from service in each year.

following periodic authorizations of these large projects, gradually rises until most construction nears completion and then tails off until a round of new project authorizations. These lumpy patterns are also reflected in retirement and depreciation schedules. Falling net investment in this category between 1978 and 1985 represents at most a longer-than-usual tailing-off period rather than a long-term decline in real investment, especially in view of the new project authori-

TABLE 4. NET FEDERAL PHYSICAL INVESTMENT AFTER DEDUCTING EQUAL ANNUAL AMOUNTS FOR DEPRECIATION (NIPA basis, in millions of dollars, at 1982 prices)

	Structures					
	Civilian Nonresidential					
	Buildings			Other Civilian Nonresidential		
Year	Industrial	Hospital and Education	Other	Highways	Conservation and Development	Other
1949	112	595	122	162	2,295	38
1959	-734	80	347	222	1,816	61
1969	-887	105	-160	369	1,012	-54
1970	-923	185	-247	411	1,240	-8
1971	-683	228	-163	437	1,619	35
1972	-1,033	95	-61	422	1,543	244
1973	-664	122	137	290	1,665	373
1974	-757	108	-28	126	1,696	235
1975	-920	131	76	161	1,650	228
1976	-878	144	-220	216	1,665	255
1977	-835	206	817	282	1,717	223
1978	-787	246	233	217	2,478	218
1979	-734	221	156	227	1,964	82
1980	-683	250	107	72	1,836	70
1981	-630	291	109	352	1,499	-21
1982	-578	191	-164	288	895	-2
1983	-529	148	19	103	686	-6
1984	-485	196	231	122	416	-5
1985	-444	198	374	24	257	-165
1986	-430	220	406	-44	125	172

SOURCE: Congressional Budget Office, based on data from the Bureau of Economic Analysis.

zations in the Omnibus Water Resources Development Act of 1986. Net investment in 1986 was up.

Spending on physical capital in this category illustrates the need for appropriate measures of investment valuation and capital consumption (depreciation). On the one hand, dams and other heavy structures are constructed to last virtually indefinitely. Moreover, leaving aside pumping machinery or turbines that are included in

TABLE 4. (Continued)

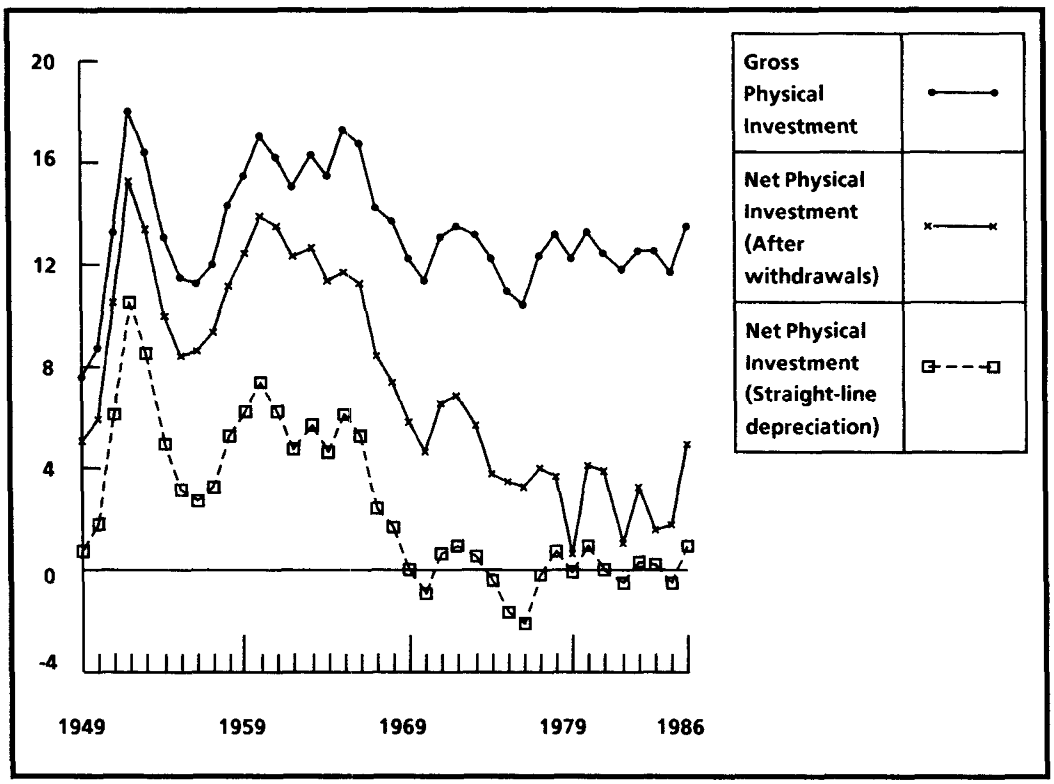
Structures (Continued)		Equipment		
Residential Investment	Military Structures	Industrial	Other	Net Federal Investment Type 1 a/
-755	-2,274	1,010	-553	753
1,673	1,919	585	224	6,193
19	-1,464	847	211	-3
117	-2,098	853	-430	-900
741	-1,724	1,038	-921	607
1,650	-1,671	-841	555	903
1,438	-1,608	-444	-756	552
1,118	-1,862	-518	-544	-427
-31	-1,269	-785	-900	-1,659
-182	-1,577	-744	-763	-2,084
81	-1,675	-288	-701	-174
411	-1,715	-5	-580	717
-47	-1,928	170	-236	-125
285	-1,574	88	465	915
216	-1,895	-15	112	17
116	-1,476	1,019	-861	-572
553	-983	938	-656	272
832	-841	-129	-137	201
937	-519	-68	61	-212
1,486	-297	-656	192	1,173

a. Net Federal Investment Type 1 is gross investment less straight-line depreciation.

equipment investments, using water from reservoirs does not cause the dams to wear out. These considerations argue for low depreciation rates on these structures over very long lives. Economic evaluations of projects constructed by the Corps of Engineers, for example, project that users will enjoy full services for 100 years.

On the other hand, experience with large dams is limited; the major construction phase began only in the late 1920s, and estimates of useful lives and deterioration rates are still based on assumptions rather than on experience. Major dams have failed, and others have required remedial work to correct design faults that impaired their safety (as under the federal program that finances repairs to sub-

FIGURE 2. MEASURES OF FEDERAL PHYSICAL INVESTMENT (NIPA basis, in billions of dollars, at 1982 prices)



SOURCE: Congressional Budget Office, based on data from the Bureau of Economic Analysis.

standard structures). Furthermore, the overall operation of a dam is dependent on other parts of the structure--sluice and lock gates, for example--that have considerably shorter lives than the dam itself. This argues that, to preserve the economic usefulness of dams, depreciation charges against the incomes of water users should be large enough to allow a fairly rapid build-up of reserves to provide for rehabilitation or remedial work. For example, the Bureau of Economic Analysis estimates that are used in Tables 3 and 4 write off capital expenditures over a period of only 60 years.

Estimates of net investment in these structures differ considerably under the two approaches to depreciation, but at a maximum they would not put net federal investment in physical assets outside the $4 billion annual upper limit mentioned earlier (see Table 5). The evidence, however, tends to favor a longer life than 60 years. The reauthorization of water resources development under the Corps of Engineers' programs in 1986 included mostly new or expansion projects rather than the first rush of rehabilitation work that would be expected if the projects constructed in the 1920s and early 1930s were approaching rapid deterioration. The Bureau of Reclamation's 1988

TABLE 5. EFFECT OF VARYING ASSUMPTIONS FOR DEPRECIATION ESTIMATES ON NET INVESTMENT FOR CONSERVATION AND DEVELOPMENT OF WATER AND ENERGY RESOURCES (NIPA basis, in millions of dollars, at 1982 prices)

Asset	1970	1975	1980	1985
	Equal Annual Depreciation Deducted Each Year			
100 Years	2,186	2,667	2,923	1,236
60 Years	1,240	1,650	1,836	-96
	Depreciation Deducted Only When Asset Withdrawn			
100 Years	3,632	4,286	4,685	3,106
60 Years	3,066	3,560	3,868	2,284

SOURCE: Congressional Budget Office, based on data from the Bureau of Economic Analysis.

budget request proposed to defer advance planning for most of the new projects and reorganize the construction program to hasten completion of long-delayed projects by deferring spending on new projects.

But the projects proposed by the Corps of Engineers cannot be thought of as substitutes or supplements for deteriorating older systems. Rates of return on rehabilitation projects are typically very high, because demand has been at high levels for many years, and because the disruption resulting from supply interruption after a dam failure would be large. Returns on the new projects are low, however. As Figure 3 shows, about one-third of the Corps of Engineers' construction budget proposal for recent projects in 1988 is for projects with negative rates of return. The benefits to users of these projects once completed--benefits in the form of higher crop yields, less damage from floods, and so on--will not repay the remaining construction and maintenance costs.1/ Another 37 percent of the projects will have returns that do not cover the projected federal cost of funds, and the next 4 percent would be unattractive at business borrowing rates. Of all the projects with returns above 10.3 percent, only three (expanding or modifying existing projects) show the very high returns typical of projects that rehabilitate or expand successful older infrastructure investments, and these projects account for less than 2 percent of the new construction efforts. An approximate market valuation for the proposed water and energy resources investments could be as low as 46 percent of the construction cost of the assets.

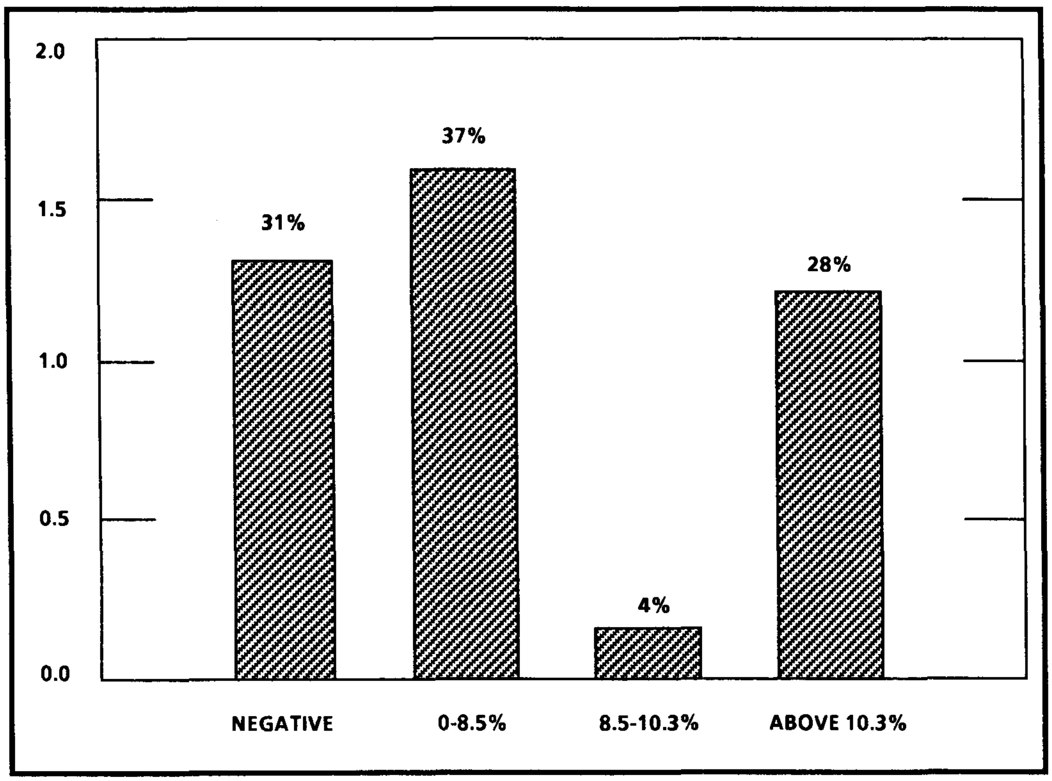
Managers of national systems for conservation and development of water and energy resources are not calling attention to deteriorated structures, nor are they constructing alternative systems that could be used to bolster supply from deteriorated structures. Managers of local and regional water systems, on the other hand, are finding many ways of improving the output or lowering the supply costs of existing systems--including trading water rights among users and localities and using regional management systems--so that the productivity of existing water resources assets seems more likely to improve in the future through management innovations than to deteriorate through structural failure.

1. Based on Army Corps of Engineers, *Detailed Budget Justifications* (1987).

Industrial Plant and Equipment

The rapid increase in net investment in federal industrial plant from negligible levels (in 1982 prices) in the late 1970s to around $1 billion in 1982 and 1983 reflects the increase in military procurement in those years. These investments are mostly in heavy engineering equipment as used in shipyards and in military construction. The remainder of net federal investment in physical assets consists of fairly small programs for constructing schools, hospitals, and other public buildings, and for federal housing construction under numerous programs. Throughout much of the last decade these investments added

FIGURE 3. COMPLETION COST AND RATE OF RETURN ON RECENT WATER PROJECTS (In billions of dollars)



SOURCE: Congressional Budget Office, based on data from Army Corps of Engineers, *Detailed Budget Justifications* (1987).

NOTE: CBO's projection of the 10-year government bond rate through 1988 is 8.5 percent. Using historical relations to the AAA-corporate rate, business long-term borrowing cost would be around 10 percent to 10.3 percent.

less than $600 million a year to net capital. Following a 75 percent increase in housing construction in 1983, and a further 95 percent jump through 1986, however, net residential investment now tops $1 billion a year.

Thus federal physical investment is concentrated in heavy construction--dams and other water resources improvements, and heavy engineering plant. Apart from occasional spurts of residential investment, direct investment in other capital sectors is small. Moreover, because of low rates of return on current projects, construction costs probably overstate the value of the investments undertaken.

EFFECT ON SAVING AND INVESTMENT MEASURES

This chapter has shown that adjusting federal accounts for federal investment activity consistent with current conventions for national accounting of physical assets would have reduced the federal deficit at most by a steady 0.1 percent of the net national product (NNP) in the years 1980 to 1986. Adding such federal net investment to national fixed investment would also slightly raise measures of the national investment rate (as a percent of NNP) without altering the general downward trend evident in the 1980s. Figure 4 illustrates these results.

While the principle of separating federal budget accounts into capital and recurrent operations accounts is fairly clear, there is some question whether adding government physical capital to national fixed investment is warranted in measuring national totals. Any estimate of federal net investment would include many investments valued at construction cost that have low or negative rates of return, when measured comparably with the business returns of private investment, because they are intended to serve general welfare or social purposes that are not easily incorporated into benefit measures and that are not reflected in national income data.

Some analysts argue, moreover, that the value of public capital (and services) in any community is reflected in its private property